Novy (F. G.)

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(THIS BULLETIN SHOULD BE PRESERVED FOR BINDING WITH OTHER NUMBERS. IF PRESERVED, THE SERIES WILL EVENTUALLY FORM USEFUL BOOKS CONTAINING SANITARY KNOWLEDGE, AND SUPPLYING IMPORTANT AID IN TEACHING HOW THE MOST DANGEROUS DISEASES ARE SPREAD AND HOW THEY MAY BE RESTRICTED.)

[247]

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Notice.—The State Board of Health desires to have the name and postoffice address of every teacher in Michigan, to make it possible to send to every teacher the "Data and statements" which the State Board of Health is required to supply in order to enable teachers to comply with Act 146, laws of 1897.

DISINFECTION OF ROOMS.

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The thorough disinfection of rooms and contents, infected with disease-producing organisms, constitutes one of the chief means for the prevention of the spread of disease. The methods which aim to accomplish this result must stand the test of a thorough laboratory trial. It may be that the requirements exacted in the laboratory are more severe than those met with in actual experience and yet this constitutes the only safe guide as to what a given agent is capable of doing. The laboratory experiment can alone decide how much of the disinfectant is to be used, the length of time it is to act, the influence of the presence or absence of moisture, and how the contents of the room are to be arranged in order to insure disinfection. It is not sufficient to pile the bedding and clothing in one or more heaps on the floor, to burn three or more pounds of sulphur for a few hours and then assume that everything has been done that can be done. The proper disinfection of a room is a most delicate experiment and should be entered upon with a full knowledge of the various conditions which are necessary to success.

There is no chemical disinfectant which will invariably yield the same result regardless of the organism to be acted upon and the surroundings or environment of that organism. Thus, while a mercuric chloride solution may destroy the cholera vibrio in a few seconds it does not follow that it will do the same with anthrax spores. Again the anthrax spores in water suspension will be destroyed by this agent much more rapidly than if suspended in a highly albuminous fluid such as blood. These and similar conditions are equally true for gaseous disinfectants. A gaseous disinfectant, even the very best, may fail simply because it is expected to do too much. We may ridicule the attempt at disinfection of a privy-vault or cesspool by means of a few pounds of

copperas but this is no more absurd than many a so-called room disinfection. This or that gaseous agent is said to lack the power of penetration and to be a mere "surface disinfectant". The latter property is an excellent one and constitutes about all that can be expected of a given gas. While it is true that a gaseous disinfectant possesses little penetrating power, that is to say it will not go through several mattresses, or bundles of blankets it should be remembered that this is a deficiency that can be easily remedied if the disinfector will do his share of the work properly.

Sulphur fumigation is used extensively for the purpose of room disinfection. Many doubts have been cast upon its efficiency; largely, perhaps, because it was expected to do too much. The causes of certain diseases such as scarlet fever, measles and small-pox are still unknown, and it is purely gratuitous to assume that because sulphur fumes do not kill anthrax spores and other resistant organisms that they are of no value for disinfection in such diseases as mentioned above. The organisms that produce these diseases are probably as easily destroyed as those of cholera, diphtheria and black-plague. The Michigan State Board of Health, through its efficient secretary Dr. Henry B. Baker, has always warmly advocated sulphur fumigation. When this method is properly carried out there can be no doubt, as may be seen from the experiments to follow, of its efficiency in restricting the spread of certain infectious diseases.

Within the past few years formaldehyde has attracted considerable attention as a disinfectant. Various forms of apparatus have been devised for its generation and employment. In view of the strong claims for formaldehyde and the grave doubts cast on sulphur dioxide, it was thought desirable to make a comparative study of the usefulness of these two agents. This investigation was undertaken largely at the request of the Michigan State Board of Health, and it is hoped that the results obtained will be directly useful to the health officers, physicians and others in this and other States.

The report covers 26 distinct room-disinfection experiments. The number of specimens exposed to the action of disinfectants and then inoculated into culture media exceeds 5,000. It will be evident from these facts that the utmost care, regardless of time, was taken in order to insure practical results.

The room, employed for all of these experiments but one, was especially suitable for the object in view. It was built as a disinfection room at the time the laboratory was constructed and was to have a capacity of 1,000 cubic feet. It really contains 1,016 cubic feet (28.8 cu. m.). In order to make the room perfectly tight the cracks in the edge of the ceiling and in the corners of the room were filled with plaster of Paris. The plaster ceiling and walls were then coated with calcimine and glue and finally given a coat of paint. It should be said that two of the walls were brick and these were not painted. The space between the plaster and wash-boards, door and window frames was caulked with putty. The same was done to the door and window on the outside of the room. The ventilator and waste-pipe opening into the room were plugged tight. During the disinfection the cracks about the door were securely closed by caulking with strips of muslin. The room thus prepared was probably as gas tight as is possible to have one. In the case of the formalin experiments there was no odor in the adjoining rooms in

which students were constantly at work. In sulphur fumigation the gas was at times noticeable in the adjoining room. This it may be incidentally mentioned is one disadvantage as compared with formaldehyde. The latter does not tend to pass out of the room, unless of course gross cracks or openings existed, whereas sulphur dioxide will always find an opening be it ever so small. Where the adjoining room is to be inhabited, as in crowded tenement houses, formaldehyde possesses a distinct advantage over sulphur.

Twenty different organisms were exposed to the action of the disinfectant. The first six, as given in the Tables, contain spores. These are anthrax, symptomatic anthrax, tetanus, malignant oedema bacilli; also the hay and potato bacilli. With the exception of the three anacrobic germs and the tubercle bacillus, the other organisms, sixteen in number, were grown on inclined agar at a temperature of 39°C. By means of a sterile, drawn out glass-tube pipette, sterile bouillon (3-4 c. c.) was added to each agar culture. The growth was thoroughly whipped up and then pipetted off into a sterile Esmarch. The suspensions thus obtained were exceedingly rich in bacteria.

The spores of anthrax were very abundant and were obtained by growing the germs on peptonless agar for several days at 39°C. The cultures of the hay and potato bacilli were likewise several days old and rich in spores. The three anaerobic organisms, those of malignant oedema, symptomatic anthrax, and tetanus were grown in glucose bouillon in hydrogen for 5-6 days. The sediment consisting chiefly of spores, was carefully drawn off by means of a sterile, drawn out pipette with as little dilution as possible.

The names of Sanarelli and Havelburg refer to the bacteria described by these men as the causes of yellow fever. The Psittacosis bacillus is the cause of a parrot disease which apparently is communicable to man. The pus producing bacteria are represented by Staphylococcus pyogenes aureus, Streptococcus pyogenes and the Green Pus bacillus.

Sputum containing many tubercle bacilli was employed in preference to pure cultures. The experiments with tubercle bacilli are not numerous but are very conclusive. After exposure, in Esmarch dishes, to the disinfectant the tuberculous material was rubbed up with sterile bouillon and injected intraperitoneally into guinea-pigs.

Sterile silk threads, bits of muslin and cover-glasses were employed in these tests. The silk threads were about 1½ c. m. long. The bits of muslin were about 1 c. m. square. Cleaned cover-glasses 20 m. m. square were cut into halves and sterilized. The letters S. M. and G. in the tables refer to silk, muslin and cover-glasses respectively.

The threads and muslin squares were thoroughly soaked in the bacterial suspensions prepared as mentioned above. Care was taken to spread out each piece of muslin; eventually each piece was turned over so as to insure thorough soaking. The impregnated threads and muslins were then transferred to sterile Esmarch dishes. The cover-glasses were smeared, on one side only, with a large loop full of the bacterial suspension.

One set of specimens thus prepared was placed for 2½-3 hrs. at 39°C. to dry. In order to insure drying the tops of the dishes were left slightly ajar. Occasionally a muslin would not dry out completely in this time and hence when exposed to the disinfectant was in reality a

moist specimen and as such would be readily disinfected. When dry the specimens were taken out of the incubator and each piece of silk and muslin was carefully loosened from the dish in order that the gas might act on all sides.

The second set of specimens, in order to prevent drying during the time that the first was undergoing desiccation, was placed in moist chambers containing some water. In spite of this precaution some specimens would become dry before the disinfectant had time to act and in such cases the specimen became as resistant as a dry one. As might be expected the cover-glass would be the first to dry, then the silk thread. When about to begin a disinfection both wet and dry sets were placed on a table in the room and the tops of the dishes were slipped to one side. The specimens were therefore in open dishes. Except in the case of the sulphur experiments there were no dishes of water in the room.

At the close of the disinfection period the tops were rapidly replaced and the dishes then taken out of the room. Each specimen was transferred to a tube of bouillon. A sterile forcep was used for each specimen. The fifteen tubes of each anaerobic set were placed together in a Novy bottle and hydrogen was passed through for 1-2 hours. All the bouillon tubes thus inoculated were placed at 35°C. for 5-7 days when they were examined and the results noted. As a result of careful, rapid work contaminations were exceedingly rare. Frequently an entire set of two or three hundred tubes would not show a single contamination.

In the tables "*" indicates that a growth has formed; on the other hand "0" indicates that the tube remains sterile. It should be stated that frequently the growth when present was very slight showing that marked attenuation of the germ had taken place, as a result of the exposure.

The specimens were invariably exposed in duplicate. Another set was kept in a cool, dark place for the same length of time as the exposed objects. These controls were then planted into bouillon at the same time as the exposed specimens.

TABLE I.—*Sulphur Disinfection.*

	3 pounds.			6 pounds.				3 pounds.			6 pounds.		
	Dry.	Wet.	Control.	Dry.	Wet.	Control.		Dry	Wet.	Control.	Dry.	Wet	Control.
Anthrax S.	**	**	*	**	**	*	Colon bacillus S.	**	00	*	**	00	*
Anthrax M.	**	**	*	**	*0	*	Colon bacillus M.	**	00	*	**	00	*
Anthrax G.	**	*0	*	00	*0	*	Colon bacillus G.	*0	00	*	00	00	*
Symptomatic anthrax S.	**	**	*	**	**	*	Sanarelli S.	**	00	*	**	00	*
Symptomatic anthrax M.	**	**	*	**	**	*	Sanarelli M.	**	00	*	**	00	*
Symptomatic anthrax G.	**	**	*	**	**	*	Sanarelli G.	*0	00	*	00	00	*
Malignant Oedema S.	**	**	*	**	**	*	Havelburg S.	**	00	*	**	00	*
Malignant Oedema M	**	*0	*	**	**	*	Havelburg M.	00	00	*	**	00	*
Malignant Oedema G.	**	**	*	00	*0	*	Havelburg G.	00	00	*	00	00	*
Tetanus S.	**	**	*	**	**	*	Psittacosis S.	**	00	*	*0	00	*
Tetanus M.	**	**	*	**	**	*	Psittacosis M.	**	00	*	**	00	*
Tetanus G.	**	**	*	**	00	*	Psittacosis G.	**	00	*	00	00	*
Hay bacillus S.	**	**	*	**	*0	*	Black Plague S.	00	00	0	00	00	*
Hay bacillus M	**	**	*	**	*0	*	Black Plague M.	00	00	0	00	00	*
Hay bacillus G.	*0	00	*	00	00	*	Black Plague G.	00	00	*	00	00	*
Potato bacillus S.	**	**	*	**	**	*	Staphylococcus pyog. aureus S.	**	00	*	**	00	*
Potato bacillus M.	**	**	*	**	**	*	Staphylococcus pyog. aureus M	**	00	*	**	00	*
Potato bacillus G.	**	**	*	**	*0	*	Staphylococcus pyog. aureus G.	**	00	*	*0	00	*
Cholera S.	00	00	0	00	00	*	Pneumonia (Fraenkel) S	00	00	*	*0	00	*
Cholera M.	00	00	0	00	00	*	Pneumonia (Fraenkel) M.	00	00	*	*0	00	*
Cholera G.	00	00	0	00	00	0	Pneumonia (Fraenkel) G.	00	00	*	00	00	*
Diphtheria S	**	00	*	00	00	*	Green Pus S.	**	00	*	**	00	*
Diphtheria M	**	00	*	00	00	*	Green Pus M.	**	00	*	**	00	*
Diphtheria G.	00	00	*	00	00	*	Green Pus G.	**	00	*	00	00	*
Glanders S.	00	00	*	00	00	*	Streptococcus pyogenes S.	**	00	*	**	00	*
Glanders M.	00	00	*	00	00	*	Streptococcus pyogenes M.	**	00	*	**	00	*
Glanders G.	00	00	0	00	00	0	Streptococcus pyogenes G.	**	00	*	00	00	*
Typhoid Fever S.	**	00	*	**	00	*							
Typhoid Fever M.	**	00	*	**	00	*	Tuberculosis (see text).						
Typhoid Fever G.	00	00	*	00	00	*							
Positive growths, including Hay Bacillus (114)								79	32	51	64	24	55
Positive growths, deducting Hay Bacillus (108)								74	28	48	60	24	52

*Indicates that a growth formed.
0 Indicates that the tube remains sterile.
The specimens were invariably exposed in duplicate.

Sulphur Experiments.

In these experiments the sulphur was placed in one or two iron water baths on tripods which were placed in a shallow basin of water. 50 c. c. or more of alcohol was added to each three pound portion of sulphur, and then set on fire. The sulphur would burn for three or four hours, and as previously stated some sulphur fumes would penetrate into the adjoining room in spite of the utmost precaution in closing up openings. The time of exposure was twenty hours. At the end of this time the room was entered and the articles were removed. When only three pounds of sulphur was used the air in the room, at the end of that period, was irritating but tolerable; whereas with six pounds of sulphur it was well nigh insupportable. The glass dishes, especially when six pounds

of sulphur were used, were coated with a white film due to finely divided sulphur. The reaction of this deposit was intensely acid due to sulphurous acid.

A maximum and minimum thermometer was placed in the room during each experiment. In the experiment with three pounds of sulphur the temperature varied from 19-28 degrees C.; while in that with 6 pounds it registered 16-29 degrees C.

The exposed objects, as a rule perfectly dry when taken out, were planted directly into bouillon. The amount of sulphur dioxide adherent to the specimens was not sufficient to act as an antiseptic and inhibit the growth of the organisms, if any life was present. The absence of such inhibiting action was ascertained by repeated and prolonged washing of the specimens of one set in slightly warmed, sterile water. No difference was observed between washed and unwashed specimens and hence in most of the experiments the washing was omitted.

The suspensions used for the exposures in Table I were the same as those used in the paraform experiments (Table II). In order to prevent growth and consequent alteration of the suspension they were kept in a jar immersed in melting ice. The results given in tables I and II are therefore strictly comparable since they are obtained with the same suspensions.

An inspection of Table I will show what sulphur fumigation is capable of doing. In the first place it will be seen that the dry specimens, as compared with the wet ones, are much more resistant to destruction. Furthermore it will be seen that all the wet specimens are killed except the tubercle bacilli and those containing spores. Sulphur, even in six pound quantities, cannot be used to destroy spore containing material or tubercle bacilli. A comparison of this table with the following will show that formaldehyde readily destroys wet spores and tubercle bacilli and this fact demonstrates the relative superiority of formalin over sulphur. In actual practice the physician is not called upon, however, to destroy spore material. With the exception of the tubercle bacillus only vegetating, actively growing, weak forms of bacteria have to be destroyed. It will be noticed that the cholera, glanders, diphtheria, black-plague, pneumonia micro-organisms are quite readily destroyed by sulphur.

With reference to the cholera vibrio it should be noted that even the control tubes fail to develop. This organism is extremely weak and mere desiccation for twenty-four hours usually suffices to destroy it. The bacillus of Black, or Bubonic plague is almost as weak as the cholera vibrio.

Six pounds of sulphur are somewhat more destructive than three pounds. This is seen in the larger number of dried specimens that fail to develop. Out of 114 dry specimens only 64 gave a growth when six pounds of sulphur were burned whereas with three pounds of sulphur 79 specimens survived. As a rule the cover-glass specimens were the first to die out. As stated before the suspensions were spread on the upper surface only of the cover-glasses, and this true surface distribution, explains the fact mentioned.

If there is a considerable escape of sulphur fumes into the surrounding rooms the results then are by no means as certain as those indicated above. Even the wet specimens of cholera, glanders, diphtheria and Eberth are not destroyed in such cases.

In order then to insure destruction of vegetating bacteria by means of sulphur fumes it is necessary that these shall be in *direct contact with water*. It is not sufficient to have several pans of water in the room or to inject steam in order to saturate the atmosphere with aqueous vapor. In some experiments one liter of water was distilled into the room in which six pounds of sulphur were being burned. The previously dried specimens were not affected any more than if no steam had been introduced.

No experiments were made with sulphur fumigations for a shorter period than 20 hours. It is highly probable that exposures for 3-6 hours as practiced in some cities are not sufficient to destroy even wet specimens. In the recent Biennial Report of the Department of Health of Chicago, published in 1897 (pp. 85 and 250) a procedure is described which is intended to test the efficiency of sulphur fumigation. Inclined agar tubes are inoculated with the potato bacillus or hay bacillus (spores) and then exposed to the sulphur fumes in the room undergoing disinfection. The tubes are then taken to the laboratory and allowed to develop in the incubator, but more usually at the room temperature. If no growth developed the conclusion was drawn that potato or hay bacillus spores had been destroyed and since these possess a marked resistance it was further assumed that the disinfection of the room itself had been thorough.

As a matter of fact the control test as outlined above is fallacious, for the simple reason that enough sulphur dioxide is taken up by the agar to act as an antiseptic but not as a germicide. Agar tubes prepared as above and exposed for 20 hours to the fumes from six pounds of sulphur are not disinfected. The agar becomes milky, or opaque white in color and becomes intensely acid due to the dissolved sulphurous acid. These tubes when placed in the incubator will invariably fail to develop not because the spores are dead but because their growth is inhibited by the presence of an antiseptic. If some of the material on the surface of such agar tube is transplanted to a fresh agar tube growth will invariably result.

This method of testing the efficiency of fumigation is therefore not to be relied upon. Moreover the spores of the potato bacillus are vastly more resistant, as seen from the following tables, than any of the common disease-producing organisms. This test it may be added is inapplicable even in formalin disinfection. 120 g. of paraform volatilized in a room of 1,000 cubic feet (4 g. per cubic meter) is not sufficient to disinfect agar tubes which have been inoculated with the two organisms mentioned. These tubes when placed in the incubator promptly develop and if after the exposure transplantations are made to fresh agar tubes the growth will be perfectly normal. This result with agar streaks will be obtained even when most of the silk, muslin and cover-glass specimens are destroyed.

Tubercle bacilli are known to possess considerable resistance, and this characteristic is well demonstrated in connection with sulphur fumigation. A specimen of sputum rich in tubercle bacilli was divided into three equal portions. These were placed in sterile Esmarch dishes. One of the dishes was exposed uncovered for twenty hours in a room where six pounds of sulphur were burned. Another dish was exposed for the same length of time in the room in which 120 g. of paraform were volatilized. After the exposure the contents of the dishes were still

moist. Bouillon however was added to each dish, and the contents then were thoroughly stirred up and injected intraperitoneally into two guinea-pigs. The third portion of sputum was not exposed to a disinfectant but was injected into a guinea-pig as a control test. The control guinea-pig died in fourteen days. The guinea-pig that received the sputum which had been exposed to sulphur fumes died in 15 days. Both of these animals showed typical experimental tuberculosis. The guinea-pig that received the sputum that was exposed to formalin vapors was killed a month later and on examination was found to be absolutely free from tuberculosis. Sulphur fumigation is, therefore, of no value even on moist sputum, and hence should not be depended upon in the disinfection of tuberculous material.

The sulphur experiments can be summarized as follows:

Sulphur fumes possess little or no action on most bacteria when in the dry state. If, however, the specimens are actually wet they will be destroyed except in the case of resistant forms such as the spore stage and tubercle bacilli. Sulphur is of no value in the disinfection of wet or dry spore-containing material, or of tubercle bacilli. It can be used for the disinfection of rooms which have been infected with ordinary disease organisms.

To insure good results in these cases, from 3 to 6 pounds of sulphur must be burned for each 1,000 cubic feet of space. The walls, floor and articles in the room should be sprayed with water. The room should be made perfectly tight and should be kept closed for at least 20 hours.

PARAFORM DISINFECTION.

Schering's disinfector and paraform pastils were employed in these experiments. Paraform, or para-formaldehyde is polymerized formaldehyde. On gentle heating it breaks up and regenerates formaldehyde. The gas thus produced will remain in this condition if moisture is present in the atmosphere. In the absence of moisture the gaseous formaldehyde will re-polymerize and hence will cease to be effective as a disinfectant. With Schering's disinfector it is maintained that sufficient water is formed by the burning alcohol to prevent this re-polymerization.

Owing to the great solubility of formaldehyde large vessels of water should not be kept in the room to be disinfected. When water is thus kept in a room scarcely any odor of formalin will remain in the room at the end of 20 hours, whereas in the absence of such water the odor at the end of the time mentioned will be intolerable. In the tabulated experiments with paraform and with formalin no vessels of water were allowed in the room.

The maximum and minimum thermometer in the room indicated a temperature of 23 to 27 degrees C. in the experiment with 60 g. of paraform and a temperature of 19 to 28 degrees C. in the experiment with 120 g. of paraform.

60 g. of paraform for 1016 cubic feet corresponds to a little over 2 g. per cubic meter of air space. 120 g. of paraform therefore represents a little over 4 g. per cubic meter. 200 to 300 c. c. of alcohol were used in order to volatilize the paraform.

As stated under sulphur fumigation, the same suspensions were used

for the tabulated paraform and sulphur experiments. From these suspensions, kept at the temperature of melting ice, the necessary silk thread, muslin square and cover-glass specimens were prepared each day, in the manner already described.

The exposed specimens were transferred, as a rule, directly to bouillon. In some cases they were previously washed with dilute sterile ammonium hydrate in order to neutralize any trace of disinfectant, but the results were in no wise different from those obtained with unwashed specimens.

TABLE II.—*Paraform Disinfection.*

		60 g.			120 g.				60 g.			120 g.		
		Dry.	Wet.	Control.	Dry.	Wet.	Control.		Dry.	Wet.	Control.	Dry.	Wet.	Control.
Anthrax	S.	**	00	*	**	*0	*	Colon Bacillus	**	00	*	**	00	*
	M.	**	00	*	**	00	*		**	00	*	**	00	*
	G.	**	*0	*	**	*0	*		00	00	*	**	*0	*
Symptomatic anthrax	S.	**	00	*	**	00	*	Sanarelli	**	00	*	**	00	*
	M.	**	00	*	*0	00	*		**	00	*	**	00	*
	G.	**	00	*	**	00	*		*0	*0	*	**	00	*
Malignant Oedema	S.	**	00	*	**	00	*	Havelburg	**	00	*	**	00	*
	M.	00	00	*	*0	00	*		**	00	*	*0	00	*
	G.	*0	00	*	*0	00	*		*0	*0	*	**	**	*
Tetanus	S.	**	00	*	**	00	*	Psittacosis	**	00	*	**	00	*
	M.	**	00	*	**	00	*		**	00	*	**	00	*
	G.	**	00	*	**	00	*		*0	00	*	**	*0	*
Hay Bacillus	S.	**	00	*	**	00	*	Black Plague	*0	00	*	*0	00	*
	M.	**	00	*	*0	00	*		00	00	*	00	00	*
	G.	*0	00	*	00	00	*		00	00	*	00	00	*
Potato Bacillus	S.	**	00	*	**	00	*	Staphylococcus pyog. aureus	**	00	*	**	00	*
	M.	**	00	*	**	00	*		**	00	*	**	00	*
	G.	**	00	*	**	00	*		**	00	*	**	00	*
Cholera	S.	00	00	0	00	00	0	Pneumonia (Fraenkel)	**	00	*	**	00	*
	M.	00	00	0	00	00	0		**	00	*	**	00	*
	G.	00	00	0	00	00	0		*0	00	*	00	00	*
Diphtheria	S.	*0	00	*	**	00	*	Green pus	**	00	*	**	00	*
	M.	*0	00	*	00	00	*		**	00	*	**	00	*
	G.	00	00	*	00	00	*		*0	00	*	00	**	*
Glanders	S.	*0	00	*	**	00	*	Streptococcus pyogenes	**	00	*	**	*0	*
	M.	00	00	*	00	00	*		**	00	*	**	00	*
	G.	00	00	*	00	00	*		**	00	*	**	00	*
Typhoid Fever	S.	**	00	*	**	00	*	Tuberculosis (see text under sulphur)						
	M.	**	00	*	**	00	*							
	G.	*0	00	*	*0	00	*							
Positive growths, including Hay Bacillus (114)									82	3	54	83	9	54
Positive growths, deducting Hay Bacillus (108)									77	3	51	80	9	51

*Indicates that a growth formed.
0Indicates that the tube remained sterile.
The specimens were invariably exposed in duplicate.

A study of Table II will show the same difference between wet and dry specimens as has been pointed out under sulphur. There is this striking difference, however, that wet spore material is thoroughly dis-

infected with formaldehyde, whereas such material is not affected by sulphur. Formaldehyde is therefore a more energetic disinfectant.

Practically all of the wet specimens were destroyed. It will be noticed, however, that 120 g. of paraform do not possess a greater action than 60 g. Indeed the results were not so good. It is possible that several of the wet specimens dried out before sufficient formalin was generated and hence they acquired the resistance of dried specimens. As might be expected the cover-glass preparations would be the first to dry out, the silk thread next and last of all the muslin squares. Of the 9 positive growths 7 were from cover-glasses and 2 from silk threads. In the first set all three of the survivals of the wet set were cover-glass preparations.

It will be noticed further that the weak disease-producing organisms such as cholera, black plague, glanders, diphtheria, are nearly all destroyed even in the dry state.

Tubercle bacilli when in a wet condition are readily destroyed by formaldehyde vapors. Here, as in the case of spore destruction, is seen the superiority of formaldehyde vapor over sulphur fumes. The experiment in disinfection of tuberculous sputum has been described in connection with the sulphur experiments.

The results obtained with Schering's Disinfector may be briefly summarized as follows:

60 g. of paraform pastils, per 1,000 cubic feet of space, are sufficient to destroy within 20 hours, all organisms regardless of whether they are present as spore or vegetating forms, *provided they are wet.* It is not sufficient to inject steam into the room. At least steam generated from one liter of water and injected into the room containing dry specimens will not alter the results. The walls and floor of the room, and whatever articles are present (previously spread out as much as possible,) should be thoroughly sprayed with water before exposure to the formalin vapors.

FORMALIN DISTILLATION.

In Table III are given the results obtained in the first trials with distillation of formalin. Formalin solutions on heating are said to readily polymerize giving rise to paraform, which is supposed to interfere with further evaporation. Obviously the cheapest and best way of employing formaldehyde as a gaseous disinfectant will be the distillation of formalin solutions. It is a matter of unnecessary expense to convert formalin into paraform and then from this regenerate formaldehyde vapors. The autoclave employed by Roux and Trillat in their experiments with formalin gave excellent results. Unfortunately the size, weight and expense of such an apparatus precludes its general use, and limits it to the Health Boards of large cities, and to large hospitals.

The fear of polymerization of formalin on boiling, is not well grounded. Certain it is that formalin can be distilled from its aqueous solution without polymerization, and that the results obtained are in every way equal to those obtained with paraform, and decidedly superior to the so-called formalin lamps. We have made no tests with formalin lamps being convinced that they were but ephemeral play things which would not fulfil the requirements of practical disinfection.

TABLE III.—*Formalin Disinfection.*

		60 g. rapid distillation.			120 g. slow distillation.		
		Dry.	Wet.	Control	Dry.	Wet.	Control
Anthrax	S.	**	00	*	**	00	*
	M.	**	00	*	**	00	*
	G.	■■	00	*	**	**	*
Symptomatic anthrax	S.	**	00	*	**	■■	*
	M.	**	00	*	**	00	■
	G.	**	**	*	**	**	■
Malignant Oedema	S.	**	00	*	**	**	*
	M.	■■	00	*	**	00	*
	G.	**	*0	*	**	**	*
Tetanus	S.	**	00	*	**	00	*
	M.	**	00	*	**	00	*
	G.	**	00	*	■■	*0	*
Hay Bacillus	S.	**	00	*	**	0*	*
	M.	■■	00	*	■■	00	*
	G.	*0	00	*	**	00	*
Potato Bacillus	S.	**	00	*	**	**	*
	M.	**	00	*	**	00	*
	G.	**	00	*	**	**	*
Cholera	S.	00	00	*	00	00	*
	M.	00	00	*	00	00	■
	G	00	00	0	00	00	0
Diphtheria	S.	**	00	*	*0	00	*
	M.	**	00	■	00	00	*
	G.	■■	00	*	**	00	*
Glanders	S.	*0	00	■	**	00	*
	M.	*0	00	*	**	00	*
	G.	00	00	0	00	00	0
Typhoid Fever	S.	**	00	*	**	*0	*
	M.	**	00	*	**	00	*
	G.	00	00	*	**	**	*
Colon Bacillus	S.	**	00	■	**	*0	*
	M.	**	00	*	**	00	*
	G.	**	**	*	*0	*0	*
Sanarelli	S	**	00	■	**	**	■
	M.	**	00	*	**	00	*
	G.	**	0*	*	**	**	*
Havelburg	S.	**	00	■	**	*0	*
	M.	**	00	■	**	*0	*
	G.	**	0*	*	**	**	■
Psittacosis	S.	**	00	*	**	**	■
	M.	**	00	*	**	00	■
	G.	**	0*	*	*0	*0	*
Black Plague	S	00	00	*	00	00	*
	M.	*0	00	*	*0	00	■
	G.	00	00	0	00	00	*
Staphylococcus pyog. aureus	S.	**	00	*	**	*0	■
	M.	**	00	*	■■	00	*
	G.	■■	■■	*	**	■■	*
Pneumonia (Fraenkel)	S.	**	00	*	**	00	*
	M.	**	00	*	*0	00	■
	G.	**	00	*	**	00	■
Green pus	S.	**	00	*	**	*0	*
	M.	**	00	*	**	00	*
	G	**	*0	■	**	**	*
Streptococcus pyogenes	S.	**	00	*	**	*0	*
	M.	**	00	*	**	00	■
	G.	**	**	*	**	*0	■
Tuberculosis							
Positive growths, including Hay Bacillus (114)		96	13	54	95	40	55
Positive growths, deducting Hay Bacillus (108)		91	13	51	89	39	52

*Indicates that a growth formed.
0Indicates that the tube remained sterile.
The specimens were invariably exposed in duplicate.

The results given in Table III were obtained by distillation of the ordinary 40 per cent. solution of formalin. 150 c. c. of formalin solution, containing therefore 60 g. of formaldehyde, were placed in a 1½ liter flask and 10 per cent. of sodium chloride was added to prevent polymerization. Subsequent experiments showed that sodium chloride was unnecessary. The flask was provided with a rubber stopper and a bent glass tube which was inserted into the room through the key-hole. The contents of the flask were then heated to boiling by means of a Bunsen Burner. In about 50 minutes the liquid was completely evaporated and at no time was there a sign of polymerization. At the end of 20 hours when the room was opened the formalin vapors were intolerable.

Table III combines the results obtained in four separate experiments. The first ten organisms were tried first, in order to test the efficiency of

the method. Subsequently suspensions of the other organisms were prepared and tested in a similar manner. These suspensions as stated in the beginning were very rich in bacteria. It should be understood that they were different from those employed in the Tables I and II.

In the first set 150 c. c. of formalin solution, representing 60 g. of pure formaldehyde, were distilled as rapidly as possible. In the second set double this amount was used corresponding to 120 g. of pure formaldehyde. The distillation in this case was carried on at a slow rate requiring about three hours to evaporate almost to dryness. It may be added incidentally that the formalin solutions employed were examined quantitatively and found to contain 39.7 per cent of formaldehyde. The temperature in the room during the first set ranged from 17-24 degrees C., whereas in the second set it ranged from 20-29 degrees C.

As a result of the slow distillation many of the cover-glass preparations and silk threads dried out before enough formalin was present in the room and hence acquired the resistance of dried specimens. This experiment is intended to show the importance of having the object to be disinfected in a wet condition and of rapid distillation of formalin. Although twice as much formalin was distilled as in the first set yet the results are decidedly inferior owing to the reason just given.

When the formalin is rapidly distilled the results are in no wise inferior to those obtained with paraform.

THIN SUSPENSIONS.

The first three tables contain the results obtained with thick suspensions prepared in the manner described. The silk thread, muslin square or cover-glasses are coated with a mass of organisms such as will hardly be met with in practice in an ordinarily well kept room. Those experiments therefore may be considered as very severe tests of the efficiency of the several methods examined. Ordinarily infectious material that may be scattered about in a room is in a fine state of division as dry dust. Even when infectious material as saliva or sputum, in diphtheria, tuberculosis, etc., is spread over the surface of an article it dries down in a very thin layer and it is safe to say contains but relatively few organisms in a given area, as compared with the test specimens from thick suspensions mentioned above.

In order to obviate this objection a series of experiments were carried out, as given in Table IV, using very thin, *homogeneous* suspensions. For this purpose most of the test organisms were grown for several generations, of 12 hours each at 39 degrees C. In this way very thin, perfectly homogeneous bouillon cultures were obtained. In one or two instances where there was a tendency to form scum this was removed by filtration through a sterile absorbent cotton and glass wool filter. The anthrax and potato spore material was obtained from agar cultures. Only a portion of the surface growth was rubbed up with bouillon and diluted to about 8 c. c. with sterile bouillon and then filtered as above. Bouillon cultures of the anaerobic cultures were employed diluted with an equal volume of bouillon, and filtered to remove gross particles.

For each trial fresh specimens were prepared from these thin suspensions in exactly the same manner as in the preceding experiments. The

same suspensions were used for all four experiments given in Table IV. In order to prevent alteration in the suspensions in the $2\frac{1}{2}$ days necessary for the four experiments the suspensions were kept in a jar in melting ice. No change was observable in the material thus kept.

In experiments A, B and C the exposure lasted 20 hours as in all previous experiments. Experiment D was of only 10 hours' duration. In experiments B, C and D the vapors of formaldehyde were distilled into the room, through the key-hole, by boiling formalin solution in the apparatus to be presently described. The same room has been used for all the experiments described in this paper except in Experiment C, Table IV.

TABLE IV. (Part a.)—*Thin Suspensions.*

		Sulphur. A.		Formalin. B.		Formalin (Large room). C.			Formalin. D.	
		3 pounds 20 hours.		60 g. 20 hours.		60 g. per 1,000 cu. ft. 20 hours.			60 g. 10 hrs. exposure.	
		Dry.	Control.	Dry.	Control.	Dry.	Wet.	Control.	Dry.	Wet.
Anthrax	S.	**	*	**	*	**	00	*	00	00
	M.	**	*	**	*	00	00	*	00	00
	G.	00	*	*0	*	**	00	*	*0	00
Symptomatic anthrax	S.	**	*	**	*	**	00	*	**	00
	M.	**	*	**	*	*0	00	*	00	00
	G.	**	*	**	*	**	00	*	**	00
Malignant Oedema	S.	**	*	**	*	**	00	*	**	00
	M.	**	*	**	*	00	00	*	00	00
	G.	**	*	**	*	**	00	*	*0	00
Tetanus	S.	**	*	**	*	**	00	*	**	00
	M.	**	*	**	*	0*	------	*	00	00
	G.	**	*	**	*	*0	00	*	*0	00
Hay Bacillus (omitted)	S.	------	------	------	------	------	------	------	------	------
	M.	------	------	------	------	------	------	------	------	------
	G.	------	------	------	------	------	------	------	------	------
Potato Bacillus	S.	**	*	**	*	**	00	*	**	00
	M.	**	*	**	*	**	00	*	**	00
	G.	**	*	**	*	**	00	*	**	00
Cholera	S.	00	0	00	0	00	------	0	00	00
	M.	00	0	00	0	00	------	0	00	00
	G.	00	0	00	0	00	------	0	00	00
Diphtheria	S	**	*	**	*	00	00	*	00	00
	M.	**	*	**	*	00	00	*	00	00
	G.	00	*	*0	*	00	00	*	00	00
Glanders	S.	**	*	00	*	*0	------	*	00	00
	M.	*0	*	00	*	00	------	*	00	00
	G.	00	*	00	0	00	------	*	00	00
Typhoid Fever	S.	**	*	*0	*	**	------	*	00	00
	M.	**	*	**	*	00	------	*	00	00
	G.	00	*	00	*	00	------	*	00	**

*Indicates that a growth formed.
0 Indicates that the tube remained sterile.
The specimens were invariably exposed in duplicate.

TABLE IV. (Part b.)—*Thin Suspensions.*

	Sulphur A.		Formalin. B.		Formalin (Large room). C.			Formalin. D.	
	3 pounds 20 hours.		60 g. 20 hours.		60 g. per 1,000 cu. ft. 20 hours.			60 g. 10 hrs. exposure.	
	Dry.	Control.	Dry.	Control.	Dry.	Wet.	Control.	Dry.	Wet.
Colon Bacillus S.	**	*	**	*	**	------	*	**	00
Colon Bacillus M.	**	*	**	*	**	------	*	**	00
Colon Bacillus G.	00	*	**	*	**	------	*	00	00
Sanarelli S.	**	*	**	*	**	------	*	**	00
Sanarelli M.	**	*	**	*	**	------	*	*0	00
Sanarelli G.	00	*	**	*	**	------	*	00	00
Havelburg S.	**	*	**	*	**	------	*	**	00
Havelburg M.	**	*	**	*	**	------	*	**	00
Havelburg G.	*0	*	**	*	00	------	*	**	00
Psittacosis S.	**	*	**	*	**	------	*	**	00
Psittacosis M.	**	*	**	*	**	------	*	**	00
Psittacosis G.	00	*	*0	*	**	------	*	*0	00
Black Plague S.	00	*	00	*	00	------	*	00	00
Black Plague M.	00	*	*0	*	00	------	*	00	00
Black Plague G.	00	0	00	*	00	------	*	00	00
Staphylococcus pyog aureus S.	**	*	**	*	**	00	*	**	00
Staphylococcus pyog aureus M.	**	*	**	*	**	00	*	**	00
Staphylococcus pyog aureus G.	*0	*	**	*	**	00	*	**	00
Pneumonia (Fraenkel) S.	**	*	**	*	**	------	*	00	00
Pneumonia (Fraenkel) M.	**	*	**	*	*0	------	*	00	00
Pneumonia (Fraenkel) G.	00	*	00	*	00	------	*	00	00
Green Pus S.	**	*	**	*	**	------	*	*0	00
Green Pus M.	**	*	**	*	**	------	*	**	00
Green Pus G.	00	*	00	*	00	------	*	00	00
Streptococcus pyogenes S.	**	*	**	*	**	00	*	**	*0
Streptococcus pyogenes M.	**	*	**	*	**	00	*	**	00
Streptococcus pyogenes G.	**	*	**	*	**	00	*	**	*0
Tuberculosis (See text Exp. B.)	------	------	------	------	------	------	------	------	------
Positive growths out of 108 specimens	75	50	81	50	67	------	51	50	4

*Indicates that a growth formed.
0Indicates that the tube remained sterile.
The specimens were invariably exposed in duplicate.

Experiment A.—A comparison of the results obtained with thin suspensions will show little or no difference with the results given in Table I. Only dry specimens were exposed since previous trials have clearly shown that three pounds of sulphur will destroy all vegetating forms in the wet condition. Omitting the hay bacillus results in Table I, inasmuch as this organism is not represented in Table IV, it will be seen that out of a total of 108 dry specimens 74 survive exposure in Table I and 75 in Exp. A., Table IV. The temperature of the room varied from 20-24 degrees C. The odor at the end of 20 hours was tolerable.

Experiment B.—In this experiment 150 c. c. of formalin solution were distilled into the room in about 30 minutes. The temperature of the

room varied from 20-22 degrees C. The odor at the end of 20 hours was tolerable. For the reason mentioned under Exp. A, only dry specimens were exposed. The results were fairly satisfactory 81 out of 108 dried specimens survived the exposure. These results, however, are by no means as good as those in Experiments C and D wherein the same method was followed. This is probably due to slower and possibly less complete distillation.

Material from the tuberculous lung cavity, very rich in tubercle bacilli was divided into three portions and placed in wide Esmarch dishes. One of these was placed at 39 degrees C. for about 3 hours till dry. A second was exposed in the wet condition and the third reserved for direct use as a control. After exposure bouillon was added to each of the dishes, the material thoroughly rubbed up and injected intraperitoneally into guinea-pigs. The control guinea-pig died in twenty-four hours as a result of diplococcus infection. The guinea-pig that received the dried material likewise died of diplococcus infection in less than three days, whereas the guinea-pig that received the material which was exposed in a wet condition survived without the slightest illness but when killed three weeks later showed small tubercular nodules in which tubercle bacilli were demonstrated. These results show that in a *dried layer* of sputum the micrococci of sputum septicaemia (Frankel's diplococcus) will survive exposure to formaldehyde and undoubtedly this is true likewise of the tubercle bacillus since it possesses in general a greater resistance than these organisms. In moist material the diplococci are killed more readily than tubercle bacilli. The latter undoubtedly escaped destruction owing to the large amount of material used (3 c. c.) and the presence of more or less of solid particles.

Experiment C.—This experiment is given as a crucial test of the value of the formalin distillation method. The large laboratory room was employed for this purpose. The dimensions of this room are $36\frac{1}{3}$ x $36\frac{1}{6}$ x$12\frac{1}{2}$ feet. It contains therefore 17,334 cubic feet (490.84 cu. m.). The room has seven large windows and two doors; also six or eight ventilating shafts which unite into a main shaft in the attic. Large cracks extended around the entire edge of the ceiling. The ventilating and cold-air shafts were plugged with bundles of old cloth. The cracks in the ceiling, about the edge of the floor, windows and doors were caulked with strips of cloth.

On the basis of 60 g. of pure formaldehyde per 1,000 cubic feet 2,600 cu. c. of the 40 per cent formalin solution was necessary for the disinfection of this room. This amount could not be added all at once to the apparatus which was employed and will presently be described. One liter of the solution was added, and in about three-fourths of an hour a second liter was added, and after a like interval the remaining quantity was introduced. A little over 3 hours was necessary to distil this amount of formalin. Attention may be called to the great advantage of this apparatus over the so-called formalin lamps, or even the paraform apparatus. The same apparatus will do for large or small rooms. If all the formalin necessary for disinfection cannot be added at once, it can be added in portions during the process itself.

The specimens were placed at the farther end of the room. A complete set of dry specimens and in addition wet specimens of spore material were exposed. At the end of 20 hours when the room was entered the

formalin vapors were intolerable, and at no time were they noticeable in the adjoining rooms.

As shown in Table IV C, all the wet spore specimens were disinfected. Of the 108 dry specimens 67 survived exposure. The fine dust taken from the floor at the farther end of the room was sterile. The dust on the top of the cases in the room had apparently lain there for a year or more. A considerable amount of this could easily be gathered by means of sterile spatula. Portions of dust, the size of a small pea, placed into bouillon showed no sign of growth for the first couple of days, eventually however a "potato bacillus" developed. Practically therefore all surface dust in the room, and a large portion of the specimens exposed were disinfected.

Experiment D.—150 c. c. of formalin solution were distilled, by means of the apparatus to be described, as rapidly as possible (*in 10 minutes*) into the disinfecting room of 1,000 cubic feet capacity. The formalin vapors were allowed to act for ten hours. The room was then opened. The vapors were present in such amount as to be insupportable. The temperature ranged from 20-22 degrees C. Both dry and wet specimens were exposed. The control tests given under C are also applicable to D since both tests were made at the same time with the same material.

Of the wet specimens only four survived. Three of these were cover-glass preparations and one a silk thread. They undoubtedly dried out before the gas had acted a sufficient length of time.

Of the 108 dry specimens only fifty survived. This it will be seen is the best result obtained in this series of experiments.

By *rapid* formalin distillation it is possible therefore to disinfect all wet material in 10 hours. Possibly one-half this time will accomplish the same result. Dried specimens of the germs of cholera, diphtheria, glanders, typhoid fever, black plague, and pneumonia were all destroyed in the same time.

No work has been done with less than 60 g. of formalin per 1,000 cubic feet.

AVAILABILITY OF FORMALIN.

While sulphur fumigation under certain conditions, as shown in the preceding experiments, is of value it is nevertheless evident that it is more obnoxious, to persons in adjoining rooms, more injurious to fabrics, and certainly less effective than formalin. There can be no question but that formalin will eventually wholly displace sulphur fumigation. Formalin, perhaps as yet, may not be obtained in every drug store but it will soon, undoubtedly, be as easy to obtain as sulphur.

As indicated heretofore, formaldehyde vapors may be obtained in three ways. First, by incomplete combustion of methyl alcohol. This is the basis of the so-called formaldehyde lamps. The slow combustion, and their uncertain action render them of very little or no practical value. The second method is to polymerize formalin, converting it into the solid form. On heating this material by means of an alcohol lamp the formaldehyde is regenerated. While this method gives excellent results and is much more certain than a formaldehyde lamp, it nevertheless possesses certain drawbacks.

In the first place an additional and unnecessary expense is created in

making paraform out of formalin, and in regenerating the gas from this compound. Again, the apparatus for heating the paraform is placed within the room to be disinfected, and remains there until the room is opened. It is not possible to disinfect a number of rooms in the course of a day, unless a corresponding number of "disinfectors" are at hand. For the disinfection of a very large room a number of such apparatuses must be employed. Moreover the apparatus almost invariably, cannot be watched either to prevent chance of fire or to control the method itself.

The third method of using formaldehyde consists in heating the commercial formalin or formol which is a 40 per cent solution of formaldehyde. Formaldehyde vapors are thus generated, and can be injected through the key-hole into the room. The statement is freely made that formaldehyde solutions cannot be heated without polymerizing and thus interfering with further evaporation. Formalin if heated slowly in an open dish may possibly polymerize, especially when concentrated to about 25 c. c., but we have never found this to take place when the formalin solution was heated rapidly in a glass flask or copper container. This fact can be utilized as the basis of a practical method for room disinfection.

Roux and Trillat devised an autoclave in which the formalin could be superheated and the resultant vapors then injected into the room. Various modifications of their apparatus have appeared from time to time. So far as our knowledge goes, none of these can be said to possess the merits of cheapness, simplicity and general usefulness. The results obtained by distillation of formalin from a glass flask (given in Table III) were such as to justify further experimentation. The outcome was the construction of a very simple apparatus shown in the accompanying sketch. A similar apparatus, designed by Prof. A. B. Stevens, has been in use in the Chemical Laboratory to produce steam for distillation purposes. The experiments with formalin described in Table IV were made with this apparatus, and are a sufficient testimonial of its usefulness.

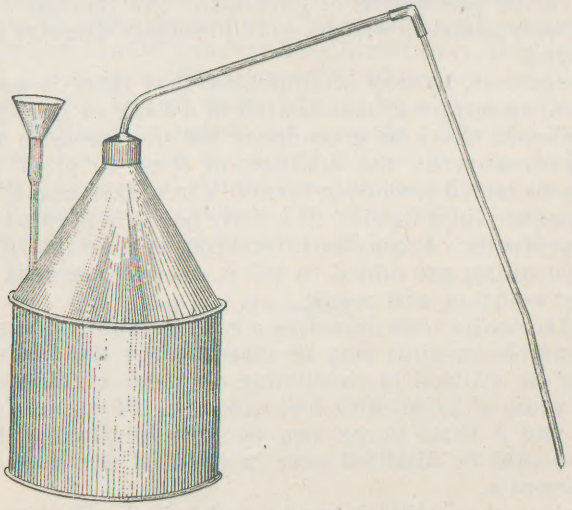

PLATE 930

The container is 6 inches in diameter. The height of the cylindrical part is 5 inches; the total height to the top of the neck is 10 inches. The capacity of the cylindrical part of the container is 2,300 c. c. An inclined tube 12 inches long and one-quarter inch in diameter screws into the neck. This is connected by means of a short piece of rubber tubing to a narrower tube which is 12 inches long and three-sixteenths of an inch in diameter. A rubber connection between the tubes is better than a rigid one. The end tube readily passes through an ordinary key-hole. The first tube is inclined to permit reflow of condensed water.

The funnel tube is prolonged into the interior of the container and extends to within one-sixteenth of an inch of the bottom. The height to the top of the funnel is 11 inches and the diameter of the funnel tube is five-sixteenths of an inch. The funnel tube serves the double purpose for introducing the formalin solution, and as an indicator of the completion of distillation. As soon as the liquid in the container has evaporated down to the level of the bottom of the funnel tube the formalin vapors and steam will issue from the tube. When therefore this tube extends down to within one-sixteenth of an inch of the bottom practically the entire quantity of the liquid can be distilled into the room to be disinfected. Not more than 10 g. of residue is left in the apparatus at the close of distillation.

The vessel is made of copper and the tubing is of brass. The apparatus is placed on a tripod and heated with a Bunsen gas burner. It may be placed on a gas or gasoline stove, or over a kerosene lamp. A portable heater similar to a plumber's lamp will undoubtedly be most useful.

The formalin should be boiled as rapidly as possible. A good Bunsen burner will distil 150 c. c. of formalin, the amount necessary for 1,000 cubic feet of space, in 10-15 minutes. Where the room is very large as in Experiment C, Table IV, the necessary amount of formalin can be added in several successive portions. It is perhaps desirable not to add the formalin too rapidly inasmuch as the rapid cooling of the contents might result in the production of paraform. An increase of heat immediately after such addition will serve to promptly dissolve any paraform that might form.

It is well to repeat, by way of emphasis, that there is no trouble with polymerization when formalin is heated in a flask or in this disinfecting apparatus. Should there be a tendency for the formalin to polymerize it could be prevented by the addition of 5 or 10 g. of borax. Solid paraform may be added to boiling formalin in a flask and it will dissolve, forming an opaque white liquid. If a little borax is present the paraform will dissolve perfectly. It may be interesting to note that if 5 g. of borax and 60 g. of paraform are added to 100 c. c. of 40 per cent formalin and heated perfect solution will result.

Commercial formalin then dissolves a considerable amount of paraform on heating, and the amount may be increased by the addition of borax. This fact may be utilized in shortening the time of distillation. Thus, to disinfect a room of 2,000 cubit feet capacity, 150 c. c. of formalin, 60 g. of paraform and a little borax can be introduced into the apparatus. This mixture could be distilled over in one-half the time necessary for 300 c. c. of formalin.

Paraform when suspended in water and boiled will cause much foaming and it cannot therefore be distilled with water in this apparatus. If

however it is added to formalin, with or without borax, it can be distilled very rapidly without the slightest foaming.

At the close of a distillation it not infrequently happens that the formalin vapor present in the container condenses and polymerizes. A solid plug of paraform is thus formed. Consequently before using the apparatus care should be taken to see that the tube is open. If this is not the case, on gentle heating the paraform will be readily volatilized, or a wire probe can be passed through the tube.

As seen from the illustration and description, the apparatus is simplicity itself, and can be made by any tinsmith. It can be obtained from the Eberbach Hardware Co. of Ann Arbor, or from Parke, Davis & Co. of Detroit.

The advantages possessed by this apparatus may be briefly summarized. One apparatus is sufficient regardless of the size of the room or rooms to be disinfected. The same apparatus can be used for almost any number of disinfections in the course of the day. The distillation of formalin into an ordinary room need not take more than 20 or 30 minutes. It is easily portable since it is very light and is not voluminous. Inasmuch as it remains on the outside of the room before the eyes of the operator, there is absolutely no danger of fire or explosion. The apparatus, formalin and fuel are inexpensive.

In conclusion the following general directions for the disinfection of rooms may be of value:—

1. All cracks or openings in the plaster or in the floor or about the door and windows should be caulked tight with cotton or with strips of cloth.

2. The linen, quilts, blankets, carpets, etc., should be stretched out on a line, in order to expose as much surface to the disinfectant as possible. They should not be thrown into a heap. Books should be suspended by their covers so that the pages are all open and freely exposed.

3. The walls and floor of the room and the articles contained in it should be thoroughly sprayed with water. If masses of matter or sputum are dried down on the floor they should be soaked with water and loosened. No vessel of water should however be allowed to remain in the room.

4. 150 c. c. (5 ounces) of the commercial 40 per cent solution of formalin for each 1,000 cubic feet of space, should be placed in the distilling apparatus, and distilled as rapidly as possible. The key-hole and spaces about the door should then be packed with cotton or cloth.

5. The room thus treated should remain closed for at least 10 hours. If there is much leakage of gas into the surrounding rooms a second or a third injection of formalin at intervals of 2 or 3 hours should be made.

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